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An admission control method

TECHNICAL FIELD OF THE INVENTION

The invention is related to radio resource usage in cellular telecommunication systems, more accurately to admission control methods used in establishing of new connections. The invention is directed to a method according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

In cellular telecommunication systems a single speech connection or data connection through the cellular telecommunication network is called a bearer. Generally, a bearer is associated with a set of parameters pertaining to data communication between a certain terminal equipment and a network element, such as a base station or an interworking unit (IWU) connecting the cellular network to another telecommunications network. The set of parameters associated with a bearer comprises typically for example data transmission speed, allowed delays, allowed bit error rate (BER), and the minimum and maximum values for these parameters. A bearer may further be a packet transmission bearer or a circuit switched bearer and support for example transparent or non-transparent connections. A bearer can be thought of as a data transmission path having the specified parameters connecting a certain mobile terminal and a certain network element for transmission of payload information. One bearer always connects only one mobile terminal to one network element. However, a bearer can pass through a number of network elements. One mobile communication means (ME, Mobile Equipment) may in some cellular telecommunication systems support one bearer only, in some other systems also more than one simultaneous bearers.

In order to be able to transmit information in a desired way, connections over the radio interface have to obtain a desired level of quality. The quality can be expressed for example as the C/I i.e. Carrier to Interference ratio, which indicates the ratio of received carrier wave power to received interfering power. Other measures for the quality of a connection are SIR i.e. Signal-to Interference ratio, S/N i.e. Signal to Noise ratio, and S/(I+N) i.e. Signal to Noise plus Interference ratio. The bit error rate (BER) or frame error rate (FER) are also used as measures of connection quality. Typically, a certain target level for one of these or other corresponding measures is determined beforehand, and for each connection, the

transmission power is adjusted to be such that the target level is reached as closely as possible. The transmission power should not be higher than what is necessary for obtaining the desired target level, since a too high transmission level wastes electrical energy in the transmitting equipment, which is crucial with handheld mobile stations, and causes interference to other connections.

Admission control is a crucial function in ensuring, that each bearer obtains the desired SIR level. The purpose of admission control is to examine each new request for a new bearer, and determine whether the requested service can be provided without degrading the service to other bearers, taking into account the transmission power of the requested bearer, the transmission bite rate of the bearer, the processing gain, and the bearer quality requirements. If the new bearer can be serviced without harming other bearers, the request is admitted. Otherwise it is scheduled i.e. put on a queue, renegotiated or modified, or rejected. Admission control typically co-operates with power control, whereby the transmission power of some of the other bearers may be adjusted in order to guarantee the SIR target level of the other bearers.

Various admission control algorithms have been proposed in the past. The article "SIR-Based Call Admission Control for DS-CDMA Cellular Systems" by Zhao Liu and Magda El Zarki, I2 Journal on selected areas in communications, vol. 12, no. 4, pp. 638-644, May 1994, describes an algorithm based on the concept of residual capacity. Residual capacity is defined as the additional number of initial calls a base station can accept. If the residual capacity is larger than zero, new calls are admitted. The residual capacity is determined from measured SIR levels and a treshold SIR level.

Another algorithms are described in the article "Call Admission in Power Controlled CDMA Systems" by Ching Yao Huang and Roy D. Yates, in proceedings of I2 VTS 46th Vehicular Technology Conference, April 28 - May 1, 1996, Atlanta, USA, pp. 1665-1669. In this article, two simple algorithms are presented. In the first algorithm, a new call is blocked when that new call would cause ongoing calls to transmit at maximum power. In the second algorithm, a new call is blocked if the total received power measured at the base station exceeds a predetermined threshold.

These algorithms function well, when the calls i.e. bearers are relatively similar in terms of resource usage, and any admission tresholds are set to a level where the admission of a bearer does not increase the load too near to the maximum capacity.

However, these algorithms do not function well, when the bearers have widely varying properties, i.e. when the network needs to handle both low bit rate bearers such as normal speech bearers, and high bit rate bearers such as high-capacity data bearers or live video bearers. Such a variety of services will be provided for example by the UMTS cellular telecommunication system presently under development. For example, in the conventional algorithm in which a new call is allowed if the total received power measured at the base station is under a predetermined treshold, a high bit rate bearer may increase the network load too near to the maximum capacity. This can be prevented by lowering the threshold so that any high rate bearers allowed close to the threshold still do not increase the total load too much, but in that case, the low bit rate speech bearers end up being refused even if the remaining capacity could accommodate them.

In this specification, the term control region is used to mean a region of the cellular telecommunication system, which is controlled by a single admission control entity or process, i.e. the region whose transmissions are taken into account when deciding about the admission of a new bearer. A control region may comprise for example a sector of a cell, a cell, or a plurality of cells such as a routing area or a whole radio access network.

In the following, various other functions of a cellular network controlling the bearers are described, namely load control, power control, and handover control.

The main task of load control (LC) is to ensure, that the cellular system is operating at a point, where high capacity is achieved without excessive usage of power in the mobile stations, while obtaining a good connection quality. The definition of the load limit, up to which the system can be allowed to be loaded, is a critical task for radio resource management. Since an overload situation may considerably undermine the performance of the network, it is essential to control the load in order to avoid an overload situation. Some examples of the main functions of load control are network balancing, adjustment of power control parameters and handover parameters, and congestion control.

The aim of power control (PC) is to adjust the power levels of the mobile stations and the base stations in order to obtain the desired signal level at the receivers at either end, i.e. take care of the near-far problem. The power control also takes care of changing the power levels as a response to large changes in shadowing and for example as a response for fast changes in SIR level.

Handover control (HC) takes care of managing the change of connections of a mobile station, when the mobile station moves from one cell to another.

Typically, these functions are implemented in a network element as software programs executed by the processing unit of the network element. The means performing these functions are in this specification called entities, i.e. a HC entity takes care of handover control, a PC entity takes care of power control, a LC entity takes care of load control, and an AC entity takes care of admission control.

SUMMARY OF THE INVENTION

An object of the invention is to realize an admission control method, which is able to maintain the system load below a predetermined limit. A further object of the invention is to realize an admission control method, which is also able to maximize the admission probability for a bearer request.

The objects are reached by arranging the admission control to produce a load estimate based at least on the bearer request, and if the load estimate is above the limit, to attempt to make room for the requested bearer or bearers.

The method according to the invention is characterized by that, which is specified in the characterizing part of the independent method claim. The dependent claims describe further advantageous embodiments of the invention.

According to the invention, bearer requests resulting in the load being under a first predetermined limit are admitted. If a bearer request would result in the load being over the first predetermined limit, the admission control entity tries to make room for the bearer request, i.e. release resources without degrading the quality of service (QoS) provided for the existing bearers. The admission control entity may perform this by adjusting power control parameters, handover control parameters, or both. If the admission control entity is able to make enough room for the new bearer or bearers, the request is admitted.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in more detail in the following with reference to the accompanying drawings, of which

figure 1 illustrates an admission control method according to an advantageous embodiment of the invention,

figure 2 illustrates an example of part of an admission control method taking care of critical load or overload situations according to an advantageous embodiment of the invention,

figure 3 illustrates a further example of a part of an admission control method taking care of critical load or overload situations according to an advantageous embodiment of the invention,

figure 4 illustrates yet another example of a part of an admission control method taking care of critical load or overload situations according to an advantageous embodiment of the invention,

figure 5 illustrates signalling of an example of an admission control method according to an advantageous embodiment of the invention,

figure 6 illustrates signalling of another example of an admission control method according to an advantageous embodiment of the invention,

figure 7 illustrates signalling of a further example of an admission control method according to an advantageous embodiment of the invention, and

figure 8 illustrates signalling of yet another example of an admission control method according to an advantageous embodiment of the invention.

Same reference numerals are used for similar entities in the figures.

DETAILED DESCRIPTION

According to the invention, a control region of a cellular network has a first predefined limit for the transmission load, which first predefined limit is the upper limit of a so called stable load region. The stable load region is a load region, within which the system can handle all traffic. The load region above the stable load region is called the critical load region. The critical load region is used as a soft capacity margin of the control region, for handling sudden changes in the amount of interference. When the load is in the critical load region, preferably only high priority calls and emergency calls should be accepted by the network. Admission control can exploit the soft capacity range to manage the dynamic-behaviour of the system by fine-tuning the "cell breathing" effect within the network. Above the critical load region is the overload region. The upper limit of the critical load region is a second predefined limit. One of the aims of the inventive admission control method is to

maintain the system load within the stable load region, while attempting to maximize the admission probability of new calls with the desired QoS.

A. AN EXAMPLE OF AN ADMISSION CONTROL METHOD

In the following, an admission control method according to an advantageous embodiment of the invention is described with reference to figures 1 and 2.

In the first step 105, a bearer request is received by the admission control entity. The bearer request may be originated by a mobile station for example if the user wishes to make a call, or by the cellular network for example if a mobile station is being called. As a response to receiving the bearer request, the admission control entity checks the current load in step 110. In this step, the admission control entity may check the load for example by requesting current load information from a load control entity. Next, the admission control entity calculates 115 a result load estimate based at least on the current load and the bearer request. Preferably, the resulting load estimate comprises the transmission i.e. interference powers of both existing bearers and the new bearer(s).

In the following step 120, the result load estimate is compared to a first predetermined limit, i.e. the upper limit of the stable load region. If the load estimate is higher than the first predetermined limit, a further procedure for handling critical load and overload situations is started 122. The procedure is described later in this specification. If the load estimate is found to be lower than the first predetermined limit in step 120, the bearer request is allowed 125, and transmission resources are allocated 130 for the bearer or bearers. The transmission resources can be for example radio resources, logical resources, codes, transmission capacity, or other resources. If the procedure for handling critical load and overload situations results in a positive decision for the bearer request, the method is continued at step 130 after the procedure.

The actual resulting load is checked in step 135 and compared to the first predetermined limit in step 140. If the load is under the first predetermined limit, the method is ended. If the load is not under the first predetermined limit, the parameters of at least one bearer are further adjusted at step 145 to bring the total load under the first predetermined limit, after which the method is ended.

The adjustment step 145 may for example comprise renegotiation of the quality of service level provided to the at least one bearer. The renegotiated or modified bearer or bearers may be the requested bearer or bearers, or previously existing bearers.

Figure 2 illustrates one example of a procedure for handling situations, in which the admission of the bearer request would result in the load level being in the critical or overload region. According to this example, one of steps 150, 151, 152, 155, and 160 is taken to relieve the load, as selected in step 149. In step 150, power control parameters such as upper and lower limits of the transmission power margins of the existing connections of a control region of the cellular system are readjusted, which may result in the lowering of transmission power for one or more existing bearers, thereby allowing the admission of new bearers. In step 151, load control parameters of the cellular network are adjusted. In step 152, soft handover and soft capacity margins of the cellular network are adjusted. In step 155, handover control parameters of a control region of the cellular system are adjusted. Such parameters typically comprise for example parameters, which define thresholds for triggering a handover (or a soft handover) from one cell to another. Adjusting the handover control (HC) parameters may result in the handover of one or more existing bearers to another control region. In the soft handover case, the adjustment may also result in addition or releasing of a branch of an existing bearer as well as in optimization of the soft capacity margin. In any case, the handover control parameter adjustment may release transmission resources in the current control region. In step 160, the parameters of one or more requested bearers are renegotiated or modified to find, if possible, suitable bearer properties having lower requirements for transmission resources.

After performing one of the steps 150, 151, 152, 155, and 160, the current load is checked 165, and a new load estimate is calculated 167. If the load estimate is now below the first predetermined limit, the request is allowed 180, and the method is continued at step 130 of figure 1. In case the adjustments or renegotiations of steps 150, 155, and 160 were not large enough and the load estimate is still above the first predetermined limit, the bearer request is refused 175 and the admission control method is ended.

Figure 3 illustrates a further example of a procedure for handling situations, in which the admission of the bearer request would result in the load level being in the critical or overload region. According to this example, both power control parameters and handover control parameters of the control region of the cellular network are adjusted in steps 150 and 155 to relieve the load.

After performing the steps 150 and 155 the current load is checked 165, and a new load estimate is calculated 167. If the load estimate is now below the first predetermined limit, the request is allowed 180, and the method is continued at step

130 of figure 1. In case the adjustments of steps 150 and 155 were not large enough and the load estimate is still above the first predetermined limit, the bearer request is refused 175 and the admission control method is ended.

Figure 4 illustrates yet another example of a procedure for handling situations, in which the admission of the bearer request would result in the load level being in the critical or overload region. In this example, the available ways 150, 155, 160 of reducing the load estimate are effected, until the load estimate is under the first predetermined limit, or until all the three ways of this example are used.

According to this example, one of steps 150, 155, and 160 is taken to relieve the load, as selected in step 149. In step 150, power control parameters of a control region of the cellular system are adjusted, which may result in the lowering of transmission power for one or more existing bearers, thereby allowing the admission of new bearers. In step 155, handover control parameters of a control region of the cellular system are adjusted. Such parameters typically comprise for example parameters, which define thresholds for triggering a handover from one cell to another. Adjusting the handover control (HC) parameters may result in the handover of one or more existing bearers to another control region. In the soft handover case, the adjustment may also result in addition or releasing of a branch of an existing bearer as well as in optimization of the soft capacity margin. In any case, the handover control parameter adjustment may release transmission resources in the current control region. In step 160, the parameters of one or more requested bearers are renegotiated or modified to find, if possible, suitable bearer properties having lower requirements for transmission resources.

After performing one of the steps 150,155, and 160, the current load is checked 165, and a new load estimate is calculated 167. If the load estimate is now below the first predetermined limit, the request is allowed 180, and the method is continued at step 130 of figure 1. In case the adjustments or renegotiations of steps 150, 155, or 160 were not large enough and the load estimate is still above the first predetermined limit, it is checked in step 185, if all of the available ways of relieving the load are used i.e. if all of the steps 150, 155, and 160 are already taken. If these steps are taken, the request is refused in step 175 and the admission control method is ended. If at least one of these steps have not yet been taken, the method returns to step 149.

In the previous examples, the selection of the way to relieve the load in step 149 may be performed according to any criteria as demanded by the requirements of the particular application. For example, if the properties of the requested bearers are

such that a relatively large reduction in the use of transmission resources can be obtained without a too large reduction in the service level actually needed by the user, it is advantageous to renegotiate or modify the properties of at least one bearer. Further, the selection can be performed for example depending on how much the load estimate exceeds the first predetermined limit. The selection may also be performed in a random fashion. Different bearer types may also be treated in a different way. For example, preference can be given to real time bearers by adjusting first the properties of non-real time bearers.

In a further advantageous embodiment of the invention, instead of performing the step 145 of further adjustment of parameters of at least one bearer, the requested bearer may be rejected, scheduled i.e. put on a queue, or renegotiated or modified.

In a further advantageous embodiment of the invention, if the load estimate in the first estimation steps 115 and 120 if found to be much higher than the first predetermined limit, i.e. more than a predefined amount above the first predefined limit, the bearer request can be rejected directly without starting the process 122 for handling critical and overload situations.

B. CALCULATION OF A LOAD ESTIMATE

In this section, one example of a suitable calculation method for use in an admission control method according to the invention is described. According to this example, the determination of available capacity and whether the load will increase above the first predetermined limit is based on the SIR level in the control region and the SIR level required by the requested bearer or bearers.

We assume that the total capacity below the limit of stable load of the control region is C_{tot}. The available system capacity C_a is then

$$C_a = C_{tot} - C_{oc} = \left(1 + \frac{\frac{W}{R_b}}{\frac{E_b}{N_o}} + \alpha - \frac{\nu}{S}\right)_{tot} - \left(1 + \frac{\frac{W}{R_b}}{\frac{E_b}{N_o}} + \alpha - \frac{\nu}{S}\right)_{oc} \qquad (1)$$

where

C_{oc} is the capacity occupied by existing bearer accesses,
S is the transmitted power level,
W is the WCDMA bandwidth,
R_b is the bit rate,

E_b is the bit energy,
N_o is the thermal noise spectral density,
ν is the background noise, and
α is the voice activity

The capacity based system performance requirement is

$$\text{Prob}(C_{oc} \geq C_{tot}) \leq \gamma \tag{2a}$$

i.e. that the probability of existing bearers requiring more capacity that is available is below a predefined system reliability limit γ. The same requirement can be expressed in terms of SIR levels as

$$\text{Prob}(SIR_{req} \geq SIR_{tot}) \leq \gamma \tag{2b}$$

The capacity of a WCDMA system is dependent on the level of interference. The minimum QoS of the requested bearer will be met if:

$$\begin{gathered}\frac{1}{SIR_{req}} \leq \left(\frac{W}{R_b}\frac{1}{\frac{E_b}{I_0}}\right)_{stable} + \left(\frac{W}{R_b}\frac{1}{\frac{E_b}{I_0}}\right)_{critical} = (Q)_{tota} \\ \Rightarrow \frac{1}{SIR_{req}} \leq \left(\frac{W}{R_b}\frac{1}{\frac{E_b}{I_{real}}}\right)_{stable} + \left(\frac{W}{R_b}\frac{1}{\frac{E_b}{I_{real}}}\right)_{critical} = (Q)_{tot}\end{gathered} \tag{3}$$

where

$$\frac{E_b}{I_{real}} = \left[\left(\frac{E_{bv}+E_{bd}}{N_0}\right)^{-1} + \left(\frac{G}{M}\right)^{-1}\right] \tag{4}$$

in which

M is the number of simultaneous users,

G is the process gain,

$\frac{E_b}{N_0}$ is the signal to noise ratio due to thermal noise and other cell interference,

E_{bv} is the signal energy per bit due to real time bearers, and

E_{bd} is the signal energy per bit due to non-real time bearers.

The requested bearer is admitted if

$$\begin{aligned} & SIR_{req} \le SIR_{tot} \\ \Rightarrow & SIR_{req} \le SIR_{stable} + SIR_{critical} - SIR_{oc} \end{aligned} \qquad (5)$$

or, in other terms,

$$SIR_{req} \le SIR_{tot} - SIR_{oc}) \le SIR_{available} \qquad (6)$$

where

SIR_{req}	is the SIR level required by the requested bearer,
SIR_{tot}	is the total SIR level within the control region,
SIR_{stable}	is the stable SIR margin that indicates the stable opration region of the system, i.e. the first predetermined limit,
$SIR_{critical}$	is the width of the critical margin, i.e. the soft capacity margin,
SIR_{oc}	is the SIR level occupied by existing bearers, and
$SIR_{available}$	is the SIR level that can be allocated to the new bearers.

In a further advantageous embodiment of the invention, the available capacity is calculated in terms of transmission power in the control area. In this embodiment, the available capacity, i.e. amount of available transmission or in other words the interference power $P_{available}$ can be calculated as follows:

$$P_{available} = (P_{stable} + P_{critical}) - \sum_{i \in m} P_m \qquad (7)$$

where

P_{stable}	is the upper limit of the stable load region, i.e. the first predetermined limit for the transmission or interference power,
$P_{critical}$	is the upper limit of the critical load region, i.e. the second predetermined limit for the transmission or interference power, and
m	is the number of simultaneous bearer accesses in the control region.

In this embodiment, the bearer request is accepted if

$$\sum P_{req} + \sum P_{oc} \le \sum P_{stable} \qquad (8)$$

where

P_{req} is the interference or transmission power of the requested bearer estimated by admission control, and

P_{oc} is the interference or transmission power level occupied by already accessed bearers.

Because the characteristics of non-real time (NRT) bearers are only partly under the control of the admission control due to the nature of NRT bearers of having varying bit rates etc., the admission or rejection decision is preferably based only on real time bearers.

Preferably, the admission is based on the real time bearers so that emergency calls have the highest priority, resulting in admitting them even when the load is in the critical load region, RT calls other than emergency calls have the second highest priority, and NRT calls have the lowest priority. Preferably, when attempting release of transmission resources various parameters of the network are adjusted so that this priority order is maintained. Consequently, the priority order allows the admission control to drop or hand over any requesting or existing calls according to their priorities.

In the case of multidiversity connections, the adjustment of transmission power of a mobile station (MS) can be effected as follows according to an advantageous embodiment of the invention. The admission control entity sets the BER (bit error rate) and FER (frame error rate) requirements and the initial E_b/N_0 setpoints for outer loop power control. The admission control entity also sets a power margin for the transmission power of a multidiversity bearer of a MS having a specified QoS. The final power adjustment decision may be performed by the MS according to the following condition, when the outer loop power control commands demand an increase of the power level:

$$P_{trx} = P_0 + DSS \leq P_{max} \in P_{margin} \qquad (9)$$

where DSS is the dynamic step size power to be added to the present transmission power level. Condition (9) states that the MS will increase the transmission power only if the increased power level is equal or smaller than a predetermined upper limit P_{max} for the transmission power of the connection, and if the increased transmission power is within said power margin for the transmission power.

The final power adjustment decision may be performed by the MS according to the following condition, when the outer loop power control commands demand a decrease of the power level:

$$P_{trx} = P_0 + DSS \geq P_{min} \in P_{margin} \qquad (10)$$

Condition (10) states that the MS will decrease the transmission power only if the decreased power level is equal to or larger than a predetermined lower limit P_{min} for the transmission power of the connection, and if the decreased transmission power is within said power margin for the transmission power.

In an advantageous embodiment of the invention, in the case of a multidiversity connection the admission control entity effects the adjustment of transmission power by setting a transmission power dynamic range. Such control of transmission power is applicable for both downlink and uplink transmit power adjusting.

C. SIGNALLING EXAMPLES

In the following, some examples of signalling according to various embodiments of the invention are described. Figures 5, 6, 7, and 8 illustrate signalling between a bearer management (BM) entity 210, an admission control (AC) entity 220, load control (LC) entity 230, power control (PC) entity 240, and a handover control (HC) entity 250.

Figure 5 illustrates signalling of an example of an admission control method according to an advantageous embodiment of the invention. First, the bearer management entity sends 310 a bearer request message BEARER_REQ to the admission control entity. The bearer request may be originated by a mobile station, or in the case of a mobile terminating call, by the network. The admission control entity checks the current load by sending 320 a CHECK_LOAD message to the load control entity, which replies by sending 330 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 340 a load estimate at least on the basis of the bearer request and the load information. In this example, the load estimate is found to be lower than the first predetermined treshold. Consequently, the AC entity sends 350 an acknowledgement message BEARER_REQ_ACK back to the BM entity.

Next, the AC entity instructs 360 the PC entity to change power control parameters due to admission of the new bearer by sending a TXPWR_UPD_REQ message, which the PC entity acknowledges by sending 370 a TXPWR_UPD_REQ_ACK message. Next, the AC entity instructs the HC entity to change handover control parameters due to admission of the new bearer by sending 380 a

HO_TRESHOLD_UPD_REQ message, which the HC entity acknowledges by sending 390 a HO_TRESHOLD_UPD_REQ_ACK message. After this, the AC entity examines the resulting situation in its control area by first requesting 400 load information from the LC entity, which sends 410 information about the current load situation to the AC entity. The AC entity then examines 420 the information, and if the load is found to be over the first predefined limit, the AC entity negotiates 430 with the bearer management entity in order to change the properties of at least one bearer in order to bring the load under the first predefined limit.

Figure 6 illustrates signalling of another example of an admission control method according to an advantageous embodiment of the invention. In the example of figure 6, the bearer request increases the load above the first predefined limit.

First, the bearer management entity sends 310 a bearer request message BEARER_REQ to the admission control entity. The bearer request may be originated by a mobile station, or in the case of a mobile terminating call, by the network. The admission control entity checks the current load by sending 320 a CHECK_LOAD message to the load control entity, which replies by sending 330 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 340 a load estimate at least on the basis of the bearer request and the load information. In this example, the load estimate is found to be higher than the first predetermined treshold. Consequently, the AC entity tries to make room for the requested bearers. In this example, the AC entity performs this by sending 341 a message to the PC entity instructing the PC entity to update the power control parameters. The PC entity lowers the transmission power of bearers, if possible, e.g. if the QoS level required by the bearers allow lowering of the transmission power in the current situation. In any case, the PC entity responds to the AC entity by sending 342 an acknowledgement message back to the AC entity. After receiving the acknowledgement message, the admission control entity checks the current load by sending 343 a CHECK_LOAD message to the load control entity, which replies by sending 344 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 345 a load estimate at least on the basis of the bearer request and the load information. In this example, the updating of the power control parameters created enough room for the requested bearer or bearers. Consequently, the AC entity sends 350 an acknowledgement message back to the BM entity.

Next, the AC entity instructs 360 the PC entity to change power control parameters due to admission of the new bearer by sending a TXPWR_UPD_REQ message, which the PC entity acknowledges by sending 370 a TXPWR_UPD_REQ_ACK message. Next, the AC entity instructs the HC entity to change handover control parameters due to admission of the new bearer by sending 380 a HO_TRESHOLD_UPD_REQ message, which the HC entity acknowledges by sending 390 a HO_TRESHOLD_UPD_REQ_ACK message. After this, the AC entity examines the resulting situation in its control area by first requesting 400 load information from the LC entity, which sends 410 information about the current load situation to the AC entity. The AC entity then examines 420 the information, and if the load is found to be over the first predefined limit, the AC entity negotiates 430 with the bearer management entity in order to change the properties of at least one bearer in order to bring the load under the first predefined limit.

Figure 7 illustrates signalling of a further example of an admission control method according to an advantageous embodiment of the invention. In the example of figure 7, the bearer request increases the load above the first predefined limit.

First, the bearer management entity sends 310 a bearer request message BEARER_REQ to the admission control entity. The bearer request may be originated by a mobile station, or in the case of a mobile terminating call, by the network. The admission control entity checks the current load by sending 320 a CHECK_LOAD message to the load control entity, which replies by sending 330 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 340 a load estimate at least on the basis of the bearer request and the load information. In this example, the load estimate is found to be higher than the first predetermined treshold. Consequently, the AC entity tries to make room for the requested bearers first by using power control. In this example, the AC entity performs this by sending 341 a message to the PC entity instructing the PC entity to update the power control parameters. The PC entity lowers the transmission power of bearers, if possible, e.g. if the QoS level required by the bearers allow lowering of the transmission power in the current situation. In any case, the PC entity responds to the AC entity by sending 342 an acknowledgement message back to the AC entity. After receiving the acknowledgement message, the admission control entity checks the current load by sending 343 a CHECK_LOAD message to the load control entity, which replies by sending 344 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 345 a load

estimate at least on the basis of the bearer request and the load information. In this example, the updating of the power control parameters did not create enough room for the requested bearer or bearers. Consequently, the AC entity tries to make room for the requested bearers by adjusting handover parameters. In this example, the AC entity sends 346 a command HO_OPTIMIZATION to the HC entity for instructing the HC entity to optimize the handover parameters in order to reduce load in the control area. Consequently, the HC entity changes the parameters controlling handover decisions, if possible without degrading the service level provided to existing bearers. The HC entity then replies by sending 347 an acknowledgement message HO_OPTIMIZATION_ACK to the AC entity. The AC entity then performs 349 again load checking and estimation procedure as described previously for example in connection with steps 343, 344, and 345. In this example, the optimizing of the handover control parameters finally created enough room for the requested bearer or bearers. Consequently, the AC entity sends 350 an acknowledgement message back to the BM entity.

Next, the AC entity instructs 360 the PC entity to change power control parameters due to admission of the new bearer by sending a TXPWR_UPD_REQ message, which the PC entity acknowledges by sending 370 a TXPWR_UPD_REQ_ACK message. Next, the AC entity instructs the HC entity to change handover control parameters due to admission of the new bearer by sending 380 a HO_TRESHOLD_UPD_REQ message, which the HC entity acknowledges by sending 390 a HO_TRESHOLD_UPD_REQ_ACK message. After this, the AC entity examines the resulting situation in its control area by first requesting 400 load information from the LC entity, which sends 410 information about the current load situation to the AC entity. The AC entity then examines 420 the information, and if the load is found to be over the first predefined limit, the AC entity negotiates 430 with the bearer management entity in order to change the properties of at least one bearer in order to bring the load under the first predefined limit.

Figure 8 illustrates signalling of yet another example of an admission control method according to an advantageous embodiment of the invention. In this example, the bearer request results in an estimated load, which is considerably above the first predetermined limit, wherefore the AC entity uses power control and handover control to make room for the requested bearers, and negotiates with the BM entity for lowering the amount of resources needed by the request.

First, the bearer management entity sends 310 a bearer request message BEARER_REQ to the admission control entity. The bearer request may be

originated by a mobile station, or in the case of a mobile terminating call, by the network. The admission control entity checks the current load by sending 320 a CHECK_LOAD message to the load control entity, which replies by sending 330 a LOAD_INFO message describing the current load situation. After receiving the load information, the admission control entity calculates 340 a load estimate at least on the basis of the bearer request and the load information. In this example, the load estimate is found to be considerably higher than the first predetermined treshold. Consequently, the AC entity tries to make room for the requested bearers first by using power control. In this example, the AC entity performs this by sending 341 a message to the PC entity instructing the PC entity to update the power control parameters. The PC entity lowers the transmission power of bearers, if possible, e.g. if the QoS level required by the bearers allow lowering of the transmission power in the current situation. The PC entity responds to the AC entity by sending 342 an acknowledgement message back to the AC entity. Further, the AC entity sends 346 a command HO_OPTIMIZATION to the HC entity for instructing the HC entity to optimize the handover parameters in order to reduce load in the control area. Consequently, the HC entity changes the parameters controlling handover decisions, if possible without degrading the service level provided to existing bearers. The HC entity then replies by sending 347 an acknowledgement message HO_OPTIMIZATION_ACK to the AC entity.

Next, the AC entity performs 348 a bearer negotiation procedure with the BM entity in order to reduce the resources required by the requested bearer or bearers, if possible. The AC entity then performs 349 again load checking and estimation procedure as described previously for example in connection with steps 343, 344, and 345. In this example, the optimization of power control and handover control parameters provided enough room for the renegotiated or modified bearer request. Consequently, the AC entity sends 350 an acknowledgement message back to the BM entity.

Next, the AC entity instructs 360 the PC entity to change power control parameters due to admission of the new bearer by sending a TXPWR_UPD_REQ message, which the PC entity acknowledges by sending 370 a TXPWR_UPD_REQ_ACK message. Next, the AC entity instructs the HC entity to change handover control parameters due to admission of the new bearer by sending 380 a HO_TRESHOLD_UPD_REQ message, which the HC entity acknowledges by sending 390 a HO_TRESHOLD_UPD_REQ_ACK message. After this, the AC entity examines the resulting situation in its control area by first requesting 400 load

information from the LC entity, which sends 410 information about the current load situation to the AC entity. The AC entity then examines 420 the information, and if the load is found to be over the first predefined limit, the AC entity negotiates 430 with the bearer management entity in order to change the properties of at least one bearer in order to bring the load under the first predefined limit.

The invention is not limited to be used in any specific area of the cellular network. The admission control method according to the invention can be used to control admission for example in a single cell, in a sector of a cell, or in a plurality of cells such as a routing area or a whole radio access network.

The control region may further divided into transmission or intereference power or SIR subregions, each having a fixed and an adaptive part of radio resources of the control region to be allocated.

The name of a given functional entity, such as the radio network controller, is often different in the context of different cellular telecommunication systems. For example, in the GSM system the functional entity corresponding to a radio network controller (RNC) is the base station controller (BSC). Therefore, the term radio network controller in the claims is intended to cover all corresponding functional entities regardless of the term used for the entity in the particular cellular telecommunication system. Further, the various command and message names such as the LOAD_INFO message name are intended to be examples only, and the invention is not limited to using the command and message names recited in this specification. Further, the term modified in the attached claims is intended to cover any changes effected to the parameters of at least one bearer, whether renegotiated or changed without renegotiation.

The invention can be used in any cellular telecommunication system, which is at least in part based on spread spectrum technology.

In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention.